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THE PLACE OF HUMAN-FACTORS IN THE WORK OF THE ATOMIC ENERGY CONTROL BOARD

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Behavioural Team

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THE PLACE OF HUMAN-FACTORS IN THE
WORK OF THE ATOMIC ENERGY CONTROL BOARD

ABSTRACT

The AECB do not effectively regulate human factors in nuclear power plants since they have no staff trained to do so. Two new positions are recommended and their activities are outlined. Special problems are identified in the certification of personnel, management information control, and in accommodating human factors to AECB style.

RÉSUMÉ

La CCEA ne réglemente pas efficacement les conditions d'ergonomie dans les centrales nucléaires parce qu'elle n'a pas de spécialistes compétents à sa disposition pour le faire. L'auteur recommande la création de deux nouveaux postes dont les fonctions sont définies. Il identifie également certains problèmes spéciaux concernant l'accréditation des employés, le contrôle de la gestion de l'information et la conciliation des principes d'ergonomie aux méthodes de la CCEA.

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PREFACE

The first draft of this report was not written clearly: if you had read that first draft, please persevere to read this draft.

In a context of admiring the activities and track record of the AECB, this report is highly critical of neglect of human factors. No scientist likes to become involved in professional areas outside his or her own acquaintance. And, relative to the daily work of the scientists at AECB, nothing could be as foreign as human factors and applied psychology. That's why Behavioural Team, largest firm practicing applied behavioural consulting in Canada, was hired. And, that is why, "dirt under the finger nails," Ben Barkow, was hired to scout about and to offer some professional perspectives.

The first draft of this inquiry, drew great ire. I hope that this draft will better underline the urgency of hiring human factors staff.

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SUMMARY AND RECOMMENDATIONS

In the course of nuclear power plant development, it is impossible to ignore human-factors issues. However, to this point, no specialists in this area have been added to the permanent staff of the AECB. People with human-factors skills are needed within the AECB. The needs and the type of people to fill them are identified.

To introduce these skills, three people must work together.

First, a human-factors person from an engineering background should be added to the Reactor Regulation Directorate. This person will assist with many aspects of regulation including facility and QA analysis, licensee evaluation, and ongoing inspection services.

Second, a human-factors person from an applied psychology background should be added to the Research division. This person will work towards the development of significant event reports which function properly when people are major elements, collate historical trend information from significant event records, validate and perform long-term study of personnel testing programs, assemble information to judge "crediting" of licensees for human interventions, and, in general, serve as a "staff" function for the other human-factors person and for others. This person will develop checklists, educational kits, and so forth for the better preparation of site officers in human-factors.

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Third, a member of the Board should "sponsor" the two new staff members and personally encourage the implementation of those recommended activities in this report which are deemed high in priority. Alternatively, the Board can decide to ignore the clear urgings of this report and not take action.

With the proper personnel in place, it will become possible for the AECB to begin effective work on several areas not previously satisfactorily addressed. These include, development and validation of operator licensing procedures, legitimate regulation of human-related facilities (such as control rooms, plant maintenance, and licensee training programs), and improved management information control (such as the precise evaluation of human-factors implicated SERs.)

INTRODUCTION

There are no human-factors specialists at the AECB. Are any needed? If so, how are they to be introduced into the organization? What are to be their roles?

To answer these questions, the following activities were undertaken:

1. Meetings were held with people within AECB.

2. People working for licensees were interviewed.

3. Various written documents were reviewed.

4. Site visits to nuclear power plants were made.

5. People at organizations with similar responsibilities were interviewed and relevant documents about other regulatory bodies were read.

6. This information was integrated.

(People who provided information for this report are listed in the Appendix.)

March 29th and 30th were spent talking to AECB staff of all levels in Ottawa.

Site visits were made to Pickering, Bruce A, Ontario Hydro headquarters, and air-traffic and airport authorities at Malton, and long phone conversations were held with AECL, NBEP, and various non-nuclear regulators. A large array of AECB documents were read. Attendance at a joint CNA-HFAC (Human Factors Association of Canada) conference provided other opportunities to ask and be told much that is relevant to this report. The study guide of questions used on March 29-30 is attached at the end of this report.

The hiring of human-factors specialists is advocated in this report. After all, much can go amuck in the design, operation, licensing, and ongoing inspection of atomic power plants. Process Control Operators do make mistakes. Often the fault inheres in "the nut that holds the steering wheel." Indeed, highly trained well-meaning plant personnel - not just "nuts" - will occasionally fail in their tasks. This can occur because of:

> -lapses in vigilance in the course of routine work (this can include the work of reviewing error trees for the millionth time),
>
> -perceptual errors in reading details (or dial readings) or noting the wrong details among several similar ones (this can include a site officer too quickly glancing at an SER which, in turn, may be a poor vehicle for conveying the essence of an incident),
>
> -falsely applying basic principles when reflex-like action would have been a better reaction (or the converse) (this can include crediting a distinguished power generation corporation for skills which they may not indeed possess or the converse of unreasonably witholding approval).

This report presents proposed organization changes. These recommendations are a result of failing to find adequate attention being paid to the human link in nuclear power production within the work of the AECB. This has two related

aspects. First, it seems to be the case that the human link does indeed matter. The central place of human designers, maintainers, and operators and, indeed, their role in the ontogenesis of circumstances which result in dread SERs, is clear. Second, it is not proper for a regulating body to assume that any licensee is doing a proper job in any critical sphere without a proper AECB review.

It is odd that the AECB lacks "defense in depth" in its own work in this specialty! It is all to easy for a condition to be overlooked by a site officer (or other Regulation staffer) and thus simply fall through the net of detection. This is particularly possible in the human design realm where expertise at AECB is limited.

The following report may be summarized as follows. First, human-factors input needs are identified. Then, a plan to introduce two people to fill the requirements is outlined. Some scenarios are described in order to illustrate how the new staffers would be integrated into AECB's work. Finally, some organizational practicalities are discussed in order to clarify the need for a "sponsor."

> Consider the following hypothetical 1983 scene. Mr. Lalonde sits in one of those pleasant wood-trimmed rooms in the Confederation Building. A group of serious looking elderly men face him. One of them asks, "Did I understand you correctly? You did say that the AECB had no psychologists to validate your operator licensing tests before that lunatic touched off the Pickering Incident last year?"

IS GREATER STRENGTH IN HUMAN-FACTORS NEEDED BY AECB?

The term "human-factors" describes the study of how people can be helped to successfully operate in their work environment. It is a mutual adjustment of men and machines. But once the environment is built, obviously, it is the men who do the adjusting! Men do indeed adjust readily and show learned adaptation to the most awful of task settings. For that reason, their adjustment is often quite invisible, except perhaps, to the trained eye of the human-factors practitioner.

For purposes of exposition, we have glossed over the subtle distinctions between human-factors, engineering psychology, and applied psychology. Where needed below they have been better defined.

Again for purposes of exposition, we have tended to focus on control room operators and their hardware. However, this should not diminish the importance to be placed on selection, training, and attention to other classes of people in AECB or the licensees' organizations. An operational definition of the licensees' spheres of study can be found in the long list of activities a page below.

The adjustment which men make to poorly designed environments is not without cost. The cost shows up in increased errors and threats to safety, higher than expected incidence of damage to plant equipment, impairments of staff

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health and physical well-being, employee turnover, and morale decrements. These tend to be large but imperceptible costs and should truly be attributed to poor behavioural design. However, for a nuclear plant, as for any comparably complex installation, any needless increase in errors is cause for concern.

To improve the situation, human-factors people apply their skills. They may have answers at their finger tips. This may be from their training or experience. Or, they may wish to observe conditions for themselves and thus to have data-based recommendations.

> As an Engineering Psychologist, I have sometimes thought it a great handicap that we don't "prescribe" in Latin or Greek - like medical doctors. People take our work to be "just common sense." I would not argue about the term "common sense;" in fact, it is a rather nice concept. And, in fact, it is rather true of our work! The handicap arises from the fact that people can not anticipate the increased power of the professional application of "just common sense" from the amateur application of it.

In the report to follow, the hiring of two, somewhat differently credentialled, human-factors staff is advocated. Why?

There are several answers to this question. First, the volume of work, in my view, requires about the equivalent of two full-time people. Second, the specialized nature of the work means that permanent staff members, somewhat experienced in nuclear matters are needed. Third, as with other professions, having amateurs "muddle through" can not be fully satisfactory, a "skilled nuclear engineer" is, at best, an "amateur psychologist." Fourth, the issues are sufficiently critical to public and reactor safety, that they do indeed merit the attentions of specialists.

Further, the licensees tend to be deficient in their attention to human-factors in

work design,

consoles,

employee counseling programs,

spot-checking operator performance,

specifying noise, light, and ventilation conditions,

training,

evaluation,

incident follow-up,

resource allocation to human issues,

overt observation of staff performance,

covert observation of staff performance,

means of reducing job boredom and loss of effectiveness,

certification analyses,

examining need to measure psychological fitness of probation staff,

personnel hiring policies,

shift-work problems,

effects of age,

alcohol/drug habits,

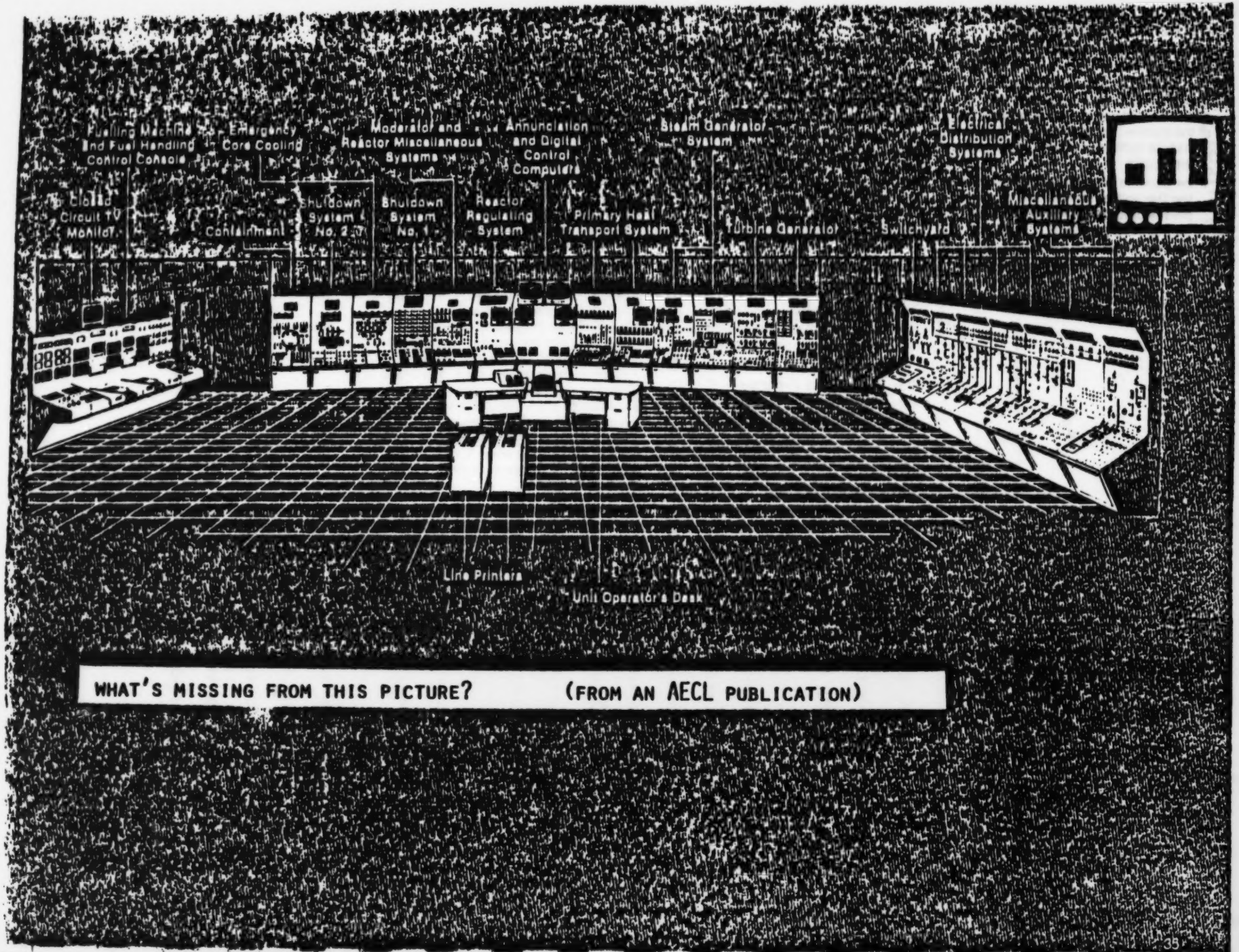
readability of Manuals,

circadian rhythms,

re-training,

job enrichment,

Quality of Work Life,



WHAT'S MISSING FROM THIS PICTURE? (FROM AN AECL PUBLICATION)

Digital computers are used to perform all the control and monitoring functions of the station. The system is designed to:

- handle both normal and abnormal situations
- be capable of automatically controlling the unit at startup and at any preselected power level within the normal loading range
- be capable of automatically shutting down the unit if unsafe conditions arise
- be tolerant of instrumentation failures

Control Programs

The functions of the overall station control system are performed by control programs loaded in each of the two unit computers. The major control function programs are described below, but there are also programs for:

- Primary Heat Transport System Control
- Moderator Temperature Control
- Turbine Runup and Monitoring
- Fuel Handling System Control

Reactor Regulation

This program adjusts the reactivity control devices to maintain reactor power equal to its desired setpoint.

Steam Generator Pressure

This program controls steam generator pressure to a constant setpoint, by changing the reactor power setpoint (normal mode), or by adjusting the station loads (alternate mode).

Steam Generator Level

This program controls the feedwater valves in order to maintain the water level in the steam generators at a reactor power dependent level setpoint.

Heat Transport System Pressure

This program controls the pressurizer steam bleed valves and heaters to maintain heat transport system pressure at a fixed setpoint.

Control Modes

Normal Mode
In this mode of operation the turbine-generator load is set by the operator; the steam generator pressure control program requests variations in reactor power to maintain steam generator pressure constant. This control mode is termed "reactor follows turbine" or "reactor follows station loads".

Alternate Mode
In this control mode, "turbine follows reactor", the station loads are made to follow the reactor output. This is achieved by the steam generator pressure control program adjusting the plant loads to maintain a constant steam generator pressure. This mode is used at low reactor power levels, during startup or shutdown, when the steam generator pressure is insensitive to reactor power. It is also used in some upset conditions when it may not be desirable to manoeuvre reactor power.

Unit Power Regulation

This program manoeuvres the unit power, by adjusting the turbine load setpoint, to maintain the generator output at the level demanded by the local operator, or by a generation control signal from a remote control centre.

upper management understanding of these issues,

simulator development,

changing requirements in personnel selection as control shifts to software manipulation,

and other areas.

The operators also tend to be deficient in knowing and/or acknowledging their deficiencies. Hence, all the more reason for a role for AECB.

The items in the list above are the traditional work of human-factors people and applied psychologists. It is true that most of the work areas in the list are thought about now and then by the licensees. Within the scope of the present review, there seems to be variation in quality and sometimes serious deficiencies in the manner and depth of analysis each has received - as viewed generally across the industry. Indeed this was the obvious conclusion of the h-f professionals at a recent Canadian nuclear industry conference.

How can AECB "call the pan black" if their own kettle is none too shiny? Within the present style of regulation, it is possible to query the licensees - after the design or proposal is ready - on their proposals and performance. However, AECB have no basis for doing so right now because of the lack of staff of proper professional qualifications. In addition, in the regulatory arena, a strong (convincing) position is needed in order to influence licensees.

THE WORK OF THE HUMAN-FACTORS PERSON IN THE REACTOR REGULATION DIRECTORATE

The first position to be discussed is the "Regulation human-factors" person. Organizationally, the person could be successfully placed under Tony Wild. Mr. Wild presently handles issues such as these and speaks knowledgebly about them. But, it should be clear that the person would be available to help others in the Reactor Regulation Directorate, with Wild's guidance.

For example, it would be valuable to develop QA guidelines in human-factors. This development would be perfectly in keeping with the larger principles of the QA discipline. Another function is to be on-hand for field inspection visits with the staff stationed at plant sites. The trained eye of the Regulation h-f person certainly would detect subtle defects which might elude a generalist site officer.

> A few years ago, there was a serious error on the part of an operator. A generator was re-connected to the grid 180 degrees out of phase. This is a sufficiently major mishap at the electrical end of things to be of concern at the nuclear end. I tried to follow-up the course of this incident. The faults related to distraction of attention, poor layout of instruments, poor indicators, lack of certain indicators, and omission of idiot-proof lock-outs. Perhaps the most serious lacks were the absence of close liaison with operators and some care in documentation and control of past experiences.
>
> Engineering h-f men tend to be shy, psychology h-f men tend to be sociable! The organization in question had only engineering h-f staff. Thus their operator liaison was definitely weak.
>
> To my surprise, the SER was quite unhelpful. You must "read between the lines" to figure out what happened. Moreover, it seemed to miss most of the causes mentioned above, in my opinion.
>
> From the point of view of this report, the most serious fact of this tale is that the AECB site office had not proceeded to make a "control chart" entry. By "control chart," I mean the class of scientifically designed paper-flow tools which serve to keep track of information

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within an organization. Since I am not aware of the use of such tools in the site office, I must assume that none has been developed for their use. With no effective control charting, there really was no means of keeping track of the paper trail of this occurance in order to review the ramifications of this incident. Thus "regulation in depth" was faulty.

At present, there are a number of skilled and experienced people in Canada who could successfully take on this work. Moreover, it is <u>not</u> difficult for a nuclear-naive person to master the atomic essentials well enough to be productive in short order. Some would even argue that a fresh viewpoint would do some good in a regulatory world of unpatterned threats to safety. Experienced people can be hired at $25,000 to $32,000, and less experienced can be hired for lesser amounts.

It is recommended that a more experienced person with 3 - 10 years experience be recruited. This person must interact with seasoned professionals from within licensee organizations. The licensees must be convinced of the rightness of the views held by AECB personnel. I believe that experienced people are personally more convincing in such working contexts.

--- What tasks need to be addressed in the first year?

The main work of the Regulation h-f persons is <u>reactive</u>. That is, he/she responds to the flow of work. Beyond this responsive work, there is need to prepare policies and working procedures for plan and process evaluations. It seems wiser to let the person <u>do</u> regulation for, say, 6 months, before starting to plan how to do it. That may seem backwards, but how else could it be done? It takes experience to make plans.

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"REGULATION" HUMAN-FACTORS PERSON

THE JOB

An engineering-oriented organization in the nuclear power field requires a person experienced in the practical application of human-factors study. The work involves review and assessment of process control and plant operation in terms of safety to plant, personnel, and neighbors, and in terms of work effectiveness and staff efficiency.

THE PERSON

In as much as the job holder will be reporting to managers coming from other scientific disciplines, it will be necessary to demonstrate past accomplishments in such settings. Since a process of review can entail criticism of plans, skill at documentation and reasoned argument - and perhaps even diplomacy - are assets. Naturally, academic degrees and formal credentials should be held. The candidate will have to be ultimately bilingual, but because the task will involve at the beginning only plants in Ontario, English only is sufficient for the first four or five years.

APPLICATION

Pay is commensurate with skill, falling in a range to $30,000. Applicants must support their applications with samples of relevant past studies and letters addressing their abilities of working in an engineering environment.

In order of priority, and with time-budget suggested, the following might consitute the first year's work:

Policy Study	Master the details of AECB regulatory style	15%
Regulation Work	Participate in the actual work of regulation	50%
Site Visits	Gain first-hand knowledge of nuclear power plants and licensees	20%
Snoozing	Friendly visiting within AECB	15%

THE WORK OF THE HUMAN-FACTORS PERSON IN THE REGULATORY RESEARCH DIRECTORATE

There are several ways in which the Regulation human-factors person is insufficient for the needs of AECB. First, he/she is likely to have been trained in the engineering tradition of human-factors. Thus, it would be valuable to have a person who is trained in different, complementary, skills. Second, since the person is busy doing regulation, there is little time left for planning long-term studies of regulation. Third, there is simply too much work for one person. Fourth, in the serious work of the AECB, two heads in a given profession are far better than only one. Fifth, having one "doer" and one "reviewer" position overcomes certain logical difficulties in plugging holes in the regulatory net. (Can a member of an AECB directorate who "approves" a design be considered an unbiased judge of the performance of that design?) Therefore, it is recommended that a second position be established in the Regulatory Research Directorate, a "Research human-factors" person.

The person would be responsible for the following:

** staff support to others at AECB, particularly for issues needing breadth and depth of study,

** longer time-frame studies of human performance - especially task analyses,

** review and validation of operator performance; measures to reliably

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certify operators, justify testing methods, and to apply task-analysis data to the operator certification process. This is presently a cause of considerable concern among the licensees. I have not been able to grasp the logic of AECB's position on the critical subject of operator licensing. This matter is discussed elsewhere in this report. And,

** to help AECB show its human face to the world (see below for further clarification.)

It may be possible to have these pieces of work accomplished by a temporary person. This might be through a one-year contract, or less desirably, through an outside consultant. Since the work can be defined by specific tasks (for example, "conduct a conceptual task-analysis of NBEP refuelling operations") the need for continuity is less than in the work of the other, Regulation, h-f person.

It is not hard to find suitable candidates for such work. The rate of pay for a mildly experienced person might be in the range of $24,000 to $28,000. Since they must be self-directed in much of their work, perhaps a person at the upper range of mild experience would be best.

If it is possible, the two h-f people should share a common workspace. They will frequently be working on joint projects. Moreover, it has been argued here that their complementarity is a valuable asset. You can't get much complementarity working in physical isolation. Also, there will be cost savings by having a shared library and other tools of the trade. Finally, AECB personnel will know just where to go when they need problem solving in

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the human sphere.

The use of temporary help in the form of specific consultant contracts might be useful because it allows AECB to get to know what it is like to work with applied psychologists on a phased-in basis. There may be questions of work style and fitting-in. Moreover, it sets a slower pace of decision making and thus defers a final choice of permanent person. It may be worth noting too that an efficient consultant costs no more than an in-house person... in my view.

Should AECB improve their contacts with the public?

I find it odd that the AECB should be so modest about themselves! While excessive tooting of one's own horn is to be decried, it does serve a purpose in a world of competing claims for dollar and political support. It is true that some bright and spontaneous managers do contact some publics. But these are mostly specialist audiences. Hard-copy transcripts of long-winded after-dinner speeches can hardly serve as attractive hand-outs to interested school kids.

There is one particular area where an applied psychology staff could do some good. I am referring to the anti-nuke debate now raging. After all, the AECB could serve as the Mr. Clean of the debate.... remember, <u>you</u> are the <u>control board</u>! If there is any actor on the "establishment" side of the debate who has (potential) credibility, it has got to be the AECB. To a degree, the AECB is associated in public minds with pro-nuclear sentiment. But, in a world where everybody has a vested interest, the AECB comes closest to being the "honest broker."

A skilled psychology h-f person could help identify sensible and modest approaches to improving the public's knowledge of the AECB. A course could be devised which avoided the excesses of dull technical words or the silly glossiness of the public relations advisor. The language could be tested for understanding - or at least, a rating on the Fog Index quickly made. Letters from the public could be systematically reviewed. A file of media references to the AECB could be kept and catalogued in a systematic fashion.

It would be advisable to recruit at least one of the h-f staff from outside

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"RESEARCH" APPLIED PSYCHOLOGIST

THE JOB

An engineering-oriented organization in the nuclear power field requires a person in a broad range of professional psychology skills. The work will include personnel licensing and longitudinal test validation, evaluation of personnel training programs in process control operations, quality-of-work-life type reviews, assistance in the development of internal paper-flow controls and procedures, a small time component related to content-analysis of media articles and assistance to managers in their contacts with the public, and in general, to serve in a "staff" function in a variety of roles.

THE PERSON

Because of the range of work, breadth of background is important. At least one degree in an applyable area of psychology and some past experience in an appropriate setting are needed. The person hired must be at ease working with another human-factors specialist and in reporting to and working alongside engineering and scientific people.

APPLICATION

Pay is commensurate with skill, falling in a range to $26,000. Applicants must support their applications with samples of relevant past studies, and letters addressing their familiarity with personnel measurement and other job aspects listed above.

the circle of Canadian nuclear firms. Naturally, there must be a balance between appropriate past experience and capacity to see beyond present horizons. In atomic regulation, it can be the unforeseen event which presents the greatest threat to safety. Thus, the person with fresh ideas may be the most useful.

---What tasks need to be addressed in the first year?

In order of priority, and with time-budget suggested, the following might constitute the first year's work:

SER Improvement	Better forms prepared and field-tested	5%
Control Charts	Paper flow tools to track AECB information	10%
Operator Licensing	Studies of reliability of grading	10%
	Studies of validity (vs. course work)	
	(vs. work perf.)	
	(vs. long-term)	40%
Public Policy	Analysis of possible policy choices	20%
Site Visits	Gain first-hand knowledge of nuclear power plants and licensees	5%
Snoozing	Friendly visiting within AECB	10%

HYPOTHETICAL CASE-STUDIES WHICH ILLUSTRATE THE PLACE OF H-F AT AECB

To illustrate the typical work of the human-factors staff, the ordinary issues presented below have been created. In the following scenarios, July, 1983 is the assumed date. That means that the two h-f people recommended in this report are settled-in at AECB.

Case One: The Nuclear Super-Cooler Control Panel

BACKGROUND CONDITIONS: Let us suppose that Yukon Hydro's new plant is slated to have a Nuclear Super-Cooler. A consultant - AEYL - has developed an instrument control list and a layout scheme to operate this device.

AECB FUTURE REACTIONS: The plans are passed to the AECB's site office. The site officers are (now, in 1983) somewhat acquainted with human issues because of the in-service upgrading they have received; it was prepared by the Research h-f man. Therefore, they know that this panel is sufficiently important that it must be reviewed in greater depth by Headquarters staff.

The transfer of responsibility is noted on a "task transfer control list." This is a simple, easy to use sheet prepared in an afternoon (and tested for effectiveness in a further three man-hours) by the Research h-f staffer.

At Headquarters, an engineering human-factors person in Regulation applies his/her specialized training to the review of the panel. There may be need to

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consult with the applied psychology human-factors person in Research. For example, evidence may have been collated showing a high incidence of errors in reading certain bar charts. In turn, there may be a request to Yukon Hydro to specify the exact nomenclature intended to be silkscreened on the instruments.

The panel could be "passed" but on condition that the operators' course include a unit on the simulator on "velocity sensitive joy-sticks." In turn, some means of measuring knowledge achievement of this unit will have to be devised. In turn, arrangements for the collection of historical data will need to be made in order to validate the measures.

It is conceivable that the Regulation Directorate review will indicate that the panel is sadly lacking. In that case, pressure may be brought to bear on AEYL to buy or rent some legitimate h-f talent and not to come back with control panel designs until they have done so!

It is conceivable that this picture necessarily differs from present AECB style. To "raise h-f questions" is roughly the same as "directing the licensee to specific problems." Thus, by implication, AECB are a party to the design.

Case Two: The New Associate Mechanic Position

BACKGROUND CONDITIONS: Yukon Hydro are finding it difficult and expensive to provide sufficient numbers of First Level Mechanics. They have therefore planned to have only a single First Level Mechanics on duty in the plant; he/she will be assisted by Second Level Mechanics.

AECB FUTURE REACTIONS: The proposed change is brought to the attention of the Research Human-Factors person by the site officer. "Why are they having these problems?" the Research person asks the site officer, "Is it true?"

Employment trends are scrutinized. Perhaps it would help to pay higher salaries. Recruitement is examined. Perhaps it would help if lower education requirements were used. Is training a valid representation of the on-the-job work?

What about testing? It may turn out that Yukon Hydro have been failing many candidates in their own courses. Is it because they are using a paper and pencil test which only measures memorizing skill for theoretical propositions? Does the exam score correlate highly with verbal fluency and correlate negatively with manual dexterity? Just what does that paper and pencil exam measure anyway?

Case Three: A Simulator Finds a Fault

BACKGROUND CONDITIONS: While running their simulator on a randon number process which generates faults, Yukon Hydro discovers a system design fault whose consequences can not be recovered from by any operator action! (This is a true story.)

AECB FUTURE REACTIONS:The Regulation h-f person is called in by the site officer. "Say, they're right." he exclaims in surprise. He checks periodically see if the site office has been satisfied on the corrections made by Yukon Hydro.

Coincidentally, the Research h-f person examines the details of the simulation that led to the discovery. Is it true that there was insufficient computer information given to the operator to solve the simulated problem? Can more experienced operators solve it? Was it really a defect of the simulation process - a process which must always depart from reality to a degree? Can the simulation be improved? Perhaps of greatest importance, can the simulator - by measuring human performance - be able to creatively discover other flaws in the working system?

ORGANIZATIONAL CHANGE AND INTERNAL SPONSORSHIP

It would not be realistic to expect the introduction of these personnel and modes of operations to be smoothly done. Easing the introduction would be the job of an internal "Sponsor" or "Godfather." Someone on The Board must take an interest in the subject matter dealt with in this report.

We are alluding to the so-called "trickle-down effect." For new policies to be enthusiastically implemented, definite signs of endorsement from the top must be visible. If the upper management of an organization is only luke-warm towards some initiative, that bodes ill for its longevity and effective implementation.

Does this material make good sense? If so, does it follow that the new positions recommended be instituted? In turn, should they be administratively located as proposed here?

Conversely, do the Behavioural Team and the Bio-technology reports make no real sense? If so, The Board must come to terms with them and prepare some rationale for dismissing them. To this point, The Board has chosen to not incorporate human factors specialists among its staff. This serves, de facto, as a policy decision.

Put plainly, this report says, "'Somebody' at AECB has been sitting on his hands. It is crazy to act like an ostrich vis a vis human factors in the post TMI era." If The Board have been negligent in reviewing this area, then perhaps new attention is called for. If staff have been negligent in advocating applied psychology upgrading to The Board, then let some needed changes begin.

Some impetus from the top will be of critical value in bringing about changes. It is recommended that a Board member take on this role. The Board are not part of the routine daily management of the AECB. Therefore, it would be a good idea for a Board member - perhaps someone with an interest in furthering his own knowledge of this fascinating professional area - to take a leading part.

The Board member who undertakes this role becomes a sponsor, a friendly encourager, and, if necessary, a strong force. His job is to see that human-factors thinking is indeed given a fair hearing and that its practitioners take their place among the professional disciplines which perform the work of the AECB.

OPERATOR LICENSING AS A SPECIAL PROBLEM

There have been serious doubts raised to us by various interested parties with regard to operator licensing. It is an area which is naturally prone to dispute since judging qualifications of individuals is bound to result in differences of opinion when done by amateurs. As elsewhere in this report, the focus is on control room operators. However, the comments apply as well to shift supervisors and other staff.

> The new Constitution of Canada and the Charter of Rights, in particular will have a great deal of impact on personnel testing here. Not unlike the situation in the US, it is now distinctly illegal to have unreliable and invalid certifying examinations. Expressed more conservatively, certifiers who can not supply normative and validative evidence for their test instruments, can be challenged in court. This is beginning to happen this summer. The AECB legal counsel should review the implications of this report relative to the Charter of Rights.

As I understand the process, the licensees attempt to train operators for effective work and, at the same time, to pass AECB tests not devised by the licensees. The AECB attempt to distill essay exam questions from the course contents (which they do not claim to prescribe) and test for student mastery.

Many students judged capable by those who know them well, fail on the test. The tests are said to include rather theoretical topics. If true, the AECB must demonstrate the relevance of theory to daily operations. If this cannot be done to prevailing standards accepted by behavioural professionals, then change is needed.

The AECB have never demonstrated to the licensees or to the public, predictive validity to these tests. Nor is it evident that such elementary techniques as item analysis, correlation of test scores and independent measures of performance, or simply multiple-scorer reliability has been tried successfully.

The tests have no published reliability or validity. It is not demonstrated that they are fair samples of the population of tasks performed by operators - since no one has done even a casual task-analysis of the operator's work. No longitudinal data have been assembled showing the relation of the student's exam score to performance, job longevity, effectiveness in emergency situations, simulator skill level, or peer ratings of operators.

> The preceeding paragraphs are an example of how "Regulation" subtly shades into "direction." As I indicate shortcomings above, I am, at the same time, indicating what ought to be done. Even a person with little experience could proceed to do the analyses I've mentioned here!
>
> I can not urge you sufficiently to improve the licensing system. It is a weakness of your work and one which causes great friction with the licensees and their chosen student operators. Should an operator-related mishap occur, the AECB will be unable to rationally defend past procedures.

This discussion of certification touches on the matter of regulatory style. The AECB wish to regulate without necessarily directing licensees. Some may feel that this approach can work in other areas. However, in the testing of personnel, the distinction becomes very blurred.

In my view, the AECB can choose to change certification policy in either of two ways:

(a) to be consistent to present style and "merely" oversee the licensees' acceptance procedures, or

(b) to recognize special circumstances in certification and to consider it a special case; therefore, the AECB would continue to be judge and jury of certification.

I feel that alternative (b) is better because it allows the AECB to continue to set standards of quality and to collect normative data on operator performance on exams. It is above suspicion of any sort since the AECB do not have a direct financial stake in the rate of passing of applicants. However, the criticisms of present certification methods outlined above must be addressed.

OTHER REGULATORS IN RELATION TO AECB

As part of this project, we have reviewed the activities of other government organizations whose responsibilities are similar to those of the AECB. The purpose of this review was to see if useful lessons could be gained through comparison.

An account of these other agencies is treated anonymously. This has been done so for a few reasons. First, the information was offered honestly and thus there is need to respect the confidentiality of the remarks. Second, this aspect of the project was not entered into in sufficient depth to provide reliable accuracy for the account of specific agencies - although the overall picture is reasonably trustworthy. Finally, as the work progressed, it became apparent that the similarities were insufficiently strong to merit strong conclusions.

However, certain general conclusions about the style of other regulating agencies in relation to human-factors can be offered. As with any broad summary, there are specific contrary instances which are glossed over.

The nuclear power industry differs from a number of other regulated industries in that the "other side" or "loyal opposition" is diffuse and not easy to define. Many industries are "regulated" by insurance companies. For example, a roller coaster is regularly inspected by provincial ministries of labour or whoever it is that looks after "elevating devices." In addition, the company

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that insures the amusement park will be sure to send around an inspector each year. I am told that the insurance inspector is a far more rigorous tester than is the representative of the province.

In nuclear power plants, there may be no clear force countervailing against ineptitude (if any) other than the AECB. The general public and interested groups, such as Energy Probe, do not have a clear focus or sufficient information access to serve as a countervailing power.

Nor is there a "loyal opposition" as exists in the air. When an Air Traffic Controller makes a mistake and (in their terms) "reduces the separation of aircraft," there is an angry pilot to write a formal complaint report. Perhaps I should say, the "pilot" or "his next of kin"! In summary, the AECB has little help in doing its job.

> A few years ago, I took part in a research study of special interest groups in Ottawa and Washington. It was surprising to discover that many pressure groups are actually creations of government agencies. They exist in order to pressure the agency in the very directions the agency really wanted to go in (but lacked the political support to do so unless aided from the outside.)

In general, regulation relates to those elements which a high school student could count. That is, a chemical analysis might be used on a drug to detect impurities. But, there would be no effort to detect and control illegible or mutually confusable drug labels. Now, a good applied psychologist could easily develop quantified methods of measuring the "goodness" of drug bottle labels. But, no high school student could do this! The AECB goes well beyond this. Site officers are obviously technically skilled. Also they do make careful judgments, not just "bacteria counts." In the area of human performance, however, they are untrained and unqualified to serve in the role.

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Longitudinal follow-up studies to validate methods are absent. Licensing exams or methodological studies of inspection are not undertaken by the regulators. If they learn of a new x-ray method to predict metal fatigue, they would seek further information from the manufacturer of the test device. An analogy would be to have two QA people perform their analyses independently to learn if results compare closely. Or, another methodological question is to ask: Will two exam graders come to apply the same grades to an operator's essay?

It is common for regulators to follow-up the continued good performance of those they certify. Of course this is not done for certain professions - no one thinks a lawyer loses his or her skill as the years go by. However, those activities which require physical well-being (motor and sensory) such flying an airplane or reading a CRT in a powerhouse from a few meters away might be recurrently examined. Re-examination can be by formal re-testing, unexpected "riding shotgun" during work, or both. It can include examinations of both cognitive and medical conditions.

Futher, certification may extend to specific sites, tools, or objects, or be an umbrella. The regulator must define the range of conditions for which the person is certified. For nuclear plant operators, this is somewhat in need of definition. AECB should judge if Bruce A, unit 1, is similar enough to what other generating units?

No other regulator that we have talked with has human-factors or applied psychology staff within their close circle of inspectors. It should be

immediately added however, that there are such specialists generally available within their ministries at large. The AECB are small and not closely tied to any ministry; thus whatever is not in-house at AECB, is not as readily useable. It is my personal observation that the other regulators have poor past records in human-related issues and should not be taken as a standard of comparison.

The first line of defense - and often the last line of defense - is the front-line inspector. This person uses personal judgment in, perhaps, 90% of instances, with formal quantitative guidelines only, perhaps, 10% of the time. Problems which elude his notice simply fall through the net of detection. The AECB does not differ from other site regulators.

Regulators differ greatly in their personnel licensing procedures. They can do their own formal licensing - as do the AECB - or they can license facilities and thus keep the responsibilities on the shoulders of the licensee organization (as do the AECB in all other matters.)

Site inspectors differ greatly in their relation to the industries they control. This ranges from abject admiration which renders the inspector useless, to abject distrust and social distance, which complicates the relationship but, strictly speaking, improves the logic of regulation. The AECB do little to control the coopting of its site officers. It is left to the discretion of the person. Alas, it is all too human to be a poor judge of one's own strengths. There are easy methods to control such problems although at some cost. One cost is loss in depth of aquaintance with an individual power plant. I feel more should be done to control this problem.

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What do regulators do after a mishap? For some organizations, there are formal Boards of Inquiry convened. Almost always, there are people at various levels who may feel that an incident need not be investigated and thus they serve as gatekeepers for formal and/or public inquiries. In all instances studied, official log books are kept by those doing or controlling the regulated process. Generally, there are quite definite rules about what is to be noted in the log book.

Retro-regulation differs too. Often, a manufacturer is granted a period of time to operate under, say, 1982 rules until 1987. Or other "grandfather" principles may be applied. However, all regulators will use friendly encouragement to keep their industry at the state of the art. This is, of course, a difficult conflict of practical operations and desirable conditions. It would be ideal if NPD had the classy control room planned for Darlington. Is it practical to ask for an expensive upgrading? Is the licensee at fault for not volunteering to upgrade? I am not sure how retro-regulation can be effected within the AECB style of regulation because it connotes a more assertive role than AECB claim to take.

Some agencies look at products, some look at processes, and some look at plans for processes or products. The AECB tend to be oriented to plans but also examine products and ongoing processes. The emphasis differs according to requirements of the industry. Allied to this parameter is the object which is observed: does the inspector measure things for himself, does he read the claims of the manufacturer and trust them, or does he do a mix of sleuthing, trust, random checking, and formal visiting "by invitation only"? Because of

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the regulatory restraint shown by the AECB, the dirtier tactics of random eye-ball inspection by non-coopted site officers are not used. This is not acceptable in the realm of human performance because humans tend to perform at their best when closely observed. And many organizations do likewise.

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People Consulted for Information

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G. Bereznai.....Ontario Hydro
F. C. Boyd.....AECB
M. Breckon.....Ontario Hydro
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F. R. Campbell.....AECB
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VISIT TO AECB MARCH 29 – 30

MAIN ISSUES FOR THIS VISIT

1. What pieces of HF(*) reside in which places?

2. Are managers satisfied with their present levels of attention to HF? If not presently sufficient, how can levels of attention be increased? If these levels were to increase, does the manager view himself as prepared to manage HF contents?

3. What has been the past experience with HF? What forms of incorporation have been successful; which not successful?

SOME SPECIFICS

1. Does HF fit neatly into existing patterns of AECB: into stages of development, into historical pattern of relationship to licensee, into present division of labour?

2. Is there a satisfactory structure and hierarchy of license review which would be jeopardized by introducting HF?

3. What examples can be offered of difficulties which arose from human fallibility? Consequences? Preventative actions which might have been effective?

4. What agencies can provide models of AECB-type regulation and from whom useful lessons can be credibly gained?

* "HF" is a short-hand term for, roughly, "the range of human behavioural considerations in sucessfully operating an atomic reactor power plant."